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Title of the Invention: Semiconductor Manufacturing Apparatus

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Spcification

1. Title of the Invention

Semiconductor Manufacturing Apparatus

2. Scope of Claim for Patent

A vaccum processing apparatus comprising a plurality of processing chambers (2, 3, 4, 5) including at least one load-lock chamber (2) arranged radially in a common evacuated vaccume chamber (1), a rotary transport mechanism (7) for transferring wafers between the processing chambers, wherein

said rotary tranport mechanism (7) has tranport arms (61, 62, 63, 64) same in number as said processing chambers (2, 3, 4, 5).

3. Detailed Description of the Invention

[Summary]

The present invention relates to a semiconductor manufacturing apparatus. More specfically, it relates to a signal-wafer processing type vaccume processing apparatus provided with a plurality of processing chambers and a wafer tranport mechanism in a common vacuume chamber, for automatically performing a plurality of processings such as dry etching, removal of resist or the

like on the semiconductor wafer.

An object is to improve processing capability of a multichamber type vacuum processing apparatus at the time of mass production.

Specifically, the present invention contemplates a multichamber type vacuum processing apparatus comprising a plurality of processing chambers including at least one load-lock chamber arranged radially in a common evacuated vacuum chamber, and a rotary transport mechanism for transporting wafers between processing chambers provided at the center in which the rotary tranport mechanism has tranport arms same in number as said processing chambers.

[Industrial Field of Application]

The present invention relates to a semiconductor manufacturing apparatus and, more specifically, to a signal-wafer processing type vacuum processing apparatus comprising a pluratliy of processing chambers and a wafer tranport mechanism within a common vacuum chamber, automatically performing a plurlaity of processings such as dry etching and resist removal on semiconductor wafers.

Preferably, semiconductor integrated circuit devices such as ASICs (Application Specific ICs) are manufactured in wide variety and small quantity. Therefore, processing of the wafer requires not only mass productivity but also flexibility in processing.

Accordingly, a vacuum processing apparatus referred to as a multichamber type apparatus has been proposed in which a plurality of reaction chambers and a load-lock chamber are arranged radially around a central wafer transport mechanism, with the wafers transported between the reaction chambers and the load-lock chamber by means of the rotary transport mechanism.

[Prior Art]

In a conventional vacuum processing apparatus, a plurality of processing chambers for performing dry etching, ashing or the like are arranged in a line, an inlet load-lock chamber is provided in the preceding portion, an outlet load-lock chamber is provided in the succeeding portion, and a linear transport mechanism for successively moving wafers to and from the plurality of vacuum chambers have been provided, as mass productivity is of highest significance. In such an apparatus, the turn of the plurality of processes is fixed and it is not flexible to allow different combinations of processes as needed. Accordingly, it is not suitable for manufacturing ASICs or the like for which process combinations differ from type to type. In view of the foregoing, a multichamber type vacuum processing apparatus such as shown in Fig. 3 has been proposed. In this type of apparatus, four reaction chambers, for example, including

a load-lock chamber 2 and three reaction chambers 3, 4 and 5 are arranged radially around an inlet/outlet gate in a common vacuum chamber, and a transport arm 7 which is retractable and rotatable by 360°C for putting in and out a wafer to and from a stage of each processing chamber is provided at the center of the arrangement of the processing chambers. Transport arm extends arm 71 to a processing chamber in which a wafer to be transported exists, the wafer on the stage is picked up by a tray 72 at the tip end, the arm is retracted and the arm is rotated by means of a rotation axis 73 to a destination processing chamber. Then the arm is extended, so that the wafer is placed on the stage of the destination chamber. By such an arrangement of processing chambers and rotary mechanism, the wafer can be transported without passing through unnecessary processing chambers. Therefore, as compared with the in line transport type processing apparatus, degree of freedom in combining processes is increased, and thus more flexible vacuum processing apparatus is implemented.

[Problems to be Solved by the Invention]

In the above described conventional vacuum apparatus, when wafers for which combination of processings is the same are to be mass-produced continuously, transport of wafer becomes linear in time, since only one wafer can be

transported at one time, as there is only one transport arm. This results in unsatisfactory throughput when a plurality of different processes are to be performed. This will be described with reference to the time sequence of Fig. 4.

This figure is a time chart showing the flow of a wafer in a dry etching apparatus having four processing chambers including one load-lock chamber. The processing chamber 1 is a load-lock chamber for performing evacuation and leak for putting in and out the wafer to the vacuum chamber, and processing chambers 2, 3 and 4 are first to third reaction chambers for performing dry etching, post processing and so on. A wafer introduced to the load-lock chamber is transported between reaction chambers by one transport arm, subjected to prescribed processing successively in respective reaction chambers, then transported again to the load-lock chamber and put out from the apparatus. The time chart shows this process.

A wafer #1 supplied to processing chamber 1 (load-lock chamber) is transported from processing chamber 1 (load-lock chamber) to processing chamber 2 (first reaction chamber) taking transport time T12, subjected to prescribed processing in processing type P1, and transported from processing chamber 2 to processing chamber 3 (second reaction chamber) taking transport time

T23. While wafer #1 is subjected to the second processing in processing time P2 in the second reaction chamber, transport arm transports a second wafer #2 from processing chamber 1 (load-lock chamber) to processing chamber 2 (first reaction chamber) taking time T12. Thereafter, wafer #1 which has grown through the second processing in processing chamber 3 (second reaction chamber) is transported to processing chamber 4 (third reaction chamber) in taking transport time T34, and the wafer is subjected to the third processing which takes time T3. During this period, transport arm must transport wafer #2 from processing chamber 3 to processing chamber 4 taking time T23, and transport a third wafer #3 which has been supplied to load-lock chamber from processing chamber 1 to processing chamber 2, taking transport time T12. In this manner, since transport arm is occupied for transporting another wafer, the wafer #1 in processing chamber 4 which has gone through processing 3 cannot be transported to processing chamber 1 (load-lock chamber). Accordingly, if T23 + T12 > T3, there is generated a transport wait time L for wafer 1. In other words, even when wafer processing is completed and the wafer is ready for transport, it cannot be transported. In the same manner, in the steady state in which wafers exit in all processing chambers, the time (tact time) from the time point at which one wafer is

completed and taken out from the load-lock chamber until the next wafer is taken out is defined by the sum of T34, T23 and T12, which is considerably long. Therefore, the conventional apparatus has poor processing capability and therefore it was not suitable for mass production.

The present invention was made in view of the above described problem, and its object is to improve processing capability of a multichamber type vacuum processing apparatus at the time of mass production.

[Means to Solve the Problems]

The above described problem can be solved by the semiconductor manufacturing apparatus in accordance with the present invention, which is a multichamber type vacuum processing apparatus comprising a plurality of processing chambers including at least one load-lock chamber arranged radially in an evacuated common vacuum chamber and a rotary transport mechanism for transferring wafer to the processing chambers provided at the center, in which the rotary transport mechanism has transport arms same in number as said processing chambers.

[Function]

Since it becomes possible to rotate a plurality of transport arms in synchronization and to transport wafers in respective processing chambers simultaneously to next processing chambers, transport wait time can be eliminated

and the processing capability can be enhanced.

[Embodiment]

An embodiment of the present invention will be described with reference to the appended figure.

Fig. 1 is a schematic plan view of an embodiment of the present invention, and Fig. 2 is a time sequence shown in the operation.

Fig. 1 shows an example of a signal-wafer processing type dry etching apparatus having four processing chambers in which reference numeral 1 denotes a common vacuum chamber surrounding four processing chambers evacuated to the same degree of the vacuum, 2 denotes a load-lock chamber having a gate valve for receiving and ejecting wafer to and from the outside of the vacuum chamber and a gate valve for internally feeding the wafer, and reference numerals 3, 4 and 5 are reaction chambers such as a dry etching chamber and a post processing chamber. These chambers are provided for stages 21, 31, 41 and 51 therein, for placing the wafer. The processing chambers are arranged radially with an opening for putting in/out the wafer positioned at the center. Reference numeral 6 denotes a rotary transport mechanism for transporting the wafer between processing chambers, which has transport arms 61 to 64 same in number as the processing chambers including load-lock chamber, attached on a rotary axis 65

with the same angle as the angle of arrangement of the processing chambers. These arms are rotatable by 360° while the relative angles between each other are maintained. Each transport arm has a retractable arm 60a and a tray 60b for mounting a wafer provided at the tip. The figure shows the state in which the arm is retracted. All ! In the state plotted by the dotted line in which the arm is extended, the wafer on the tray is placed on the stage of the processing chamber, or the wafer is picked up from the stage onto the tray.

The plurality of arms can be extended/retracted independent from each other. However, the arms are rotated simultaneously. With the arms retracted, the arms can be rotated independent from the state of processing chambers. Therefore, it is possible to operate some of the transport arms only, to move the wafer between arbitrary processing chambers, even when other processing chambers are in use. Further, if the plurality of processings mentioned above are to be performed successively, all the transport arms may be operated to pick up wafer in respective processing chambers at one time and to transport the wafers simultaneously to the next processing chambers. This operation will be described with reference to the operation sequence of Fig. 2.

First, a first wafer #1 is taken out from the evacuated load-lock chamber by an arm 1, and it is transported to a stage of the first reaction chamber. While wafer #1 is being processed, a second wafer #2 is supplied to the load-lock chamber, the gate valve on the supply side is closed and prescribed evacuation takes place. When the first reaction for the wafer #1 is completed, arm 1 transports wafer #1 to the second reaction chamber and arm 2 transports wafer #2 from the load-lock chamber to the first reaction chamber in synchronization. Thus, wafer #1 is transported between reaction chambers and successively processed, transported to the load-lock chamber by arm 1, and thereafter ejected to the outside of the apparatus. Similarly, wafer #2 is transported by arm 2, wafer #3 is transported by arm 3 and wafer #4 is transported by arm 4. After processing in each reaction chamber is completed, respective arms take out the wafers from the corresponding processing chambers and transport the wafers to the stages of the next processing chambers simultaneously and parallel to each other. After the time point A at which wafer #4 is supplied, four transfer arms operate simultaneously to transport respective wafers to the next processing chambers. In this case, the tact time from the time point at which one wafer is taken out until the next wafer is

taken out is defined by the sum of the longest one of the processing times T1 to T3 and transport time T, which is significantly reduced as compared with the conventional tact time, that is, 3T.

In the multichamber type vacuum processing apparatus in which chambers are arranged radially, it is possible to skip an unnecessary processing chamber. For example, the wafer can be taken out from the load-lock chamber after the completion of the first reaction only. Further, by providing an inlet load-lock chamber and an outlet load-lock chamber separately and by using two reaction chambers as dry etching chambers, it is possible to etch two wafers simultaneously. Therefore, the apparatus is suitable for producing various types of devices each in small quantity, as the degree of freedom in combining processes is large. As the multichamber type apparatus is combined with the multiarm system, the processing capability comparable to that of in line type apparatus can be realized.

Other embodiments may include flexible or pivotable transport arms same in number as the processing chambers attached on a rotary axis, in place of retractable transport arms. In this case, the articulate portion can be formed by a rotary bearing which has superior dustproof characteristic. Therefore, as a transport mechanism installed in a vacuum chamber, such arms may be more

convenient than retractable arms.

[Effects of the Invention]

According to the present invention, since transport arms same in number as the processing chambers are provided, the processing capability of a multichamber type vacuum processing apparatus having high degree of freedom in changing processes can be enhanced, and thus semiconductor apparatus which allows mass production and which has flexibility can be provided.

4. Brief Description of the Drawings

Fig. 1 is a schematic plan view of a multichamber type semiconductor manufacturing apparatus in accordance with the present invention.

Fig. 2 is a time sequence showing wafer processing in accordance with the apparatus of the present invention.

Fig. 3 is a schematic plan view of a conventional multichamber type semiconductor manufacturing apparatus.

Fig. 4 is a time sequence showing wafer processing by a conventional apparatus.

In the figures

1...common vacuum chamber, 2...load-lock chamber, 21... stage, 3...first reaction chamber, 4...second reaction chamber, 5...third reaction chamber, 31, 41, 51...stages, 6...rotary transport mechanism, 61, 62, 63, 64...transport arms, 65...rotary axis.